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March 10, 2011

To: Phil Isenberg, Chair, Delta Stewardship Council
Members of the Delta Stewardship Council

From: Delta Independent Science Board

Re: Review of the First Draft of the Delta Plan

The Delta Independent Science Board (Delta ISB) reviewed the first (February 14) draft of the Delta Plan and the associated "Basis of Findings" (Feb 22) and met to discuss the draft on March 3 and 4, 2011. This review summarizes the broad scientific concerns of the Delta ISB, provides general guidance applicable to the whole Delta Plan, and makes specific suggestions for improvements in coming drafts.

The Delta ISB has consistently expressed its concern with the conflict between the two roles it is being asked to play. The Delta ISB is directed by the enabling legislation to be an independent reviewer of the quality of Delta science available for managers and policy-makers. At the same time, the Delta Stewardship Council has encouraged the Delta ISB to engage in the process of developing The Delta Plan. The more the Delta ISB engages in developing The Delta Plan, the less it is able to serve as an independent reviewer of the quality of its science. In light of the Delta ISB's review of the scientific quality of the first draft of the Delta Plan, considerable engagement with the process of developing a plan is sorely needed. This tension between being independent reviewers and engaged participants structures our review.

First, in Section I, we review the quality of the scientific framing implicit in the document and deem it to fall short of the best available. The scientific description of the Delta should be explicit and the best available. We provide strong advice on what must be done to improve the scientific framing of the nature of the Delta. Next, in Section II, we provide broad advice applicable to the preparation and presentation of the Delta Plan as a whole. Lastly, in Section III, we engage in the process of helping prepare the Delta Plan by providing detailed comments and suggestions for improvement on chapters 5, 6, 8, and 9.

I. A Review of the Quality of the Scientific Framing of the First Draft

A. Base the Delta Plan on science that is explicit, adequately elaborated, and the best available. The purpose of the Delta Plan is to facilitate improved governance of the Delta so as to better meet the goals of Californians. To achieve this, the policies proposed must be consistent with the best scientific

"Coequal goals" means the two goals of providing a more reliable water supply for California and protecting, restoring, and enhancing the Delta ecosystem. The coequal goals shall be achieved in a manner that protects and enhances the unique cultural, recreational, natural resource, and agricultural values of the Delta as an evolving place."

– CA Water Code §85054

understandings of the current state, dynamic properties, and uncertainties of the Delta. The first draft does not establish the necessary base to make the necessary connections between what is known about the Delta and improved policies. Rather, while policy goals are clearly stated repeatedly, scientific studies, at best, are merely referred to as applicable to achieving the goals without sufficiently describing the science to indicate how. This approach leaves the scientific framing of the nature and dynamics of the Delta implicit rather than explicit.

As the Delta ISB struggled with the problems in the different parts of the first draft, it became clear that the implicit portrayal of the state, dynamics, and uncertainties of the Delta is not based on the best available science. In the judgment of the Delta ISB, the Delta Plan will fail, as have prior efforts to resolve the coequal goals of the Plan, if it is based on an inappropriate scientific characterization of the state, known trends, and inherently uncertain dynamics of the Delta. We elaborate key essentials of an appropriate approach in the next section.

B. Incorporate the Delta's inherent variability in time and space.

It is a truism that the Delta is a highly variable system with inherent uncertainties. There are also foreseeable broad trends due to climate change and increased human activity in the Delta, but the uncertainties with respect to how specific things will vary in the future also increase over time. Furthermore, variability and its consequences differ spatially across the Delta. While scientists and many policy-makers and planners recognize the importance of the variability, foreseeable changes, and inherent uncertainty of the Delta, these characteristics are not apparent in the first draft of the Delta Plan. For policies deriving from the Plan to be successful they must be robust to the dynamic nature and changing variability of the Delta.

We provide a few illustrations from The State of Bay Delta Science, 2008[1] to illustrate some of the kinds of variation that the Delta Plan needs to recognize and embrace. These are by no means a comprehensive illustration of variation in the Delta but will, we hope, remind the Council and those writing the plan of what must be accommodated.

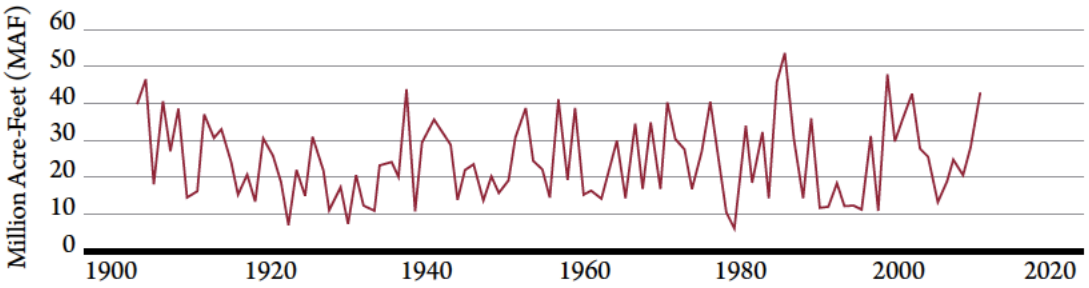

Figure 2.4. Combined Sacramento-San Joaquin River average annual unimpaired runoff for water years 1906 to 2006. The unimpaired runoff—an estimate of flows without upstream dams or diversions—shows the highly variable flow conditions from year to year. (Source: California Data Exchange Center 2007)

The first illustration shows the variation in annual runoff in the Sacramento and San Joaquin basins, ranging from a low of about 5 million acre feet (MAF) to 55 MAF. Although reservoir storage in the

[1] Healey et al. 2008. The State of Bay Delta Science 2008. Calfed Bay Delta Program.

basin is not large, about equal to one year of runoff, together with groundwater storage it helps greatly to reduce the impact of this variation. So far, runoff shows no long-term trend, only year-to-year variation. However, other variables are showing long-term changes with time. The next illustration, from Chapter 6 in The State of Bay Delta Science, shows how spring runoff has declined as climate has warmed.

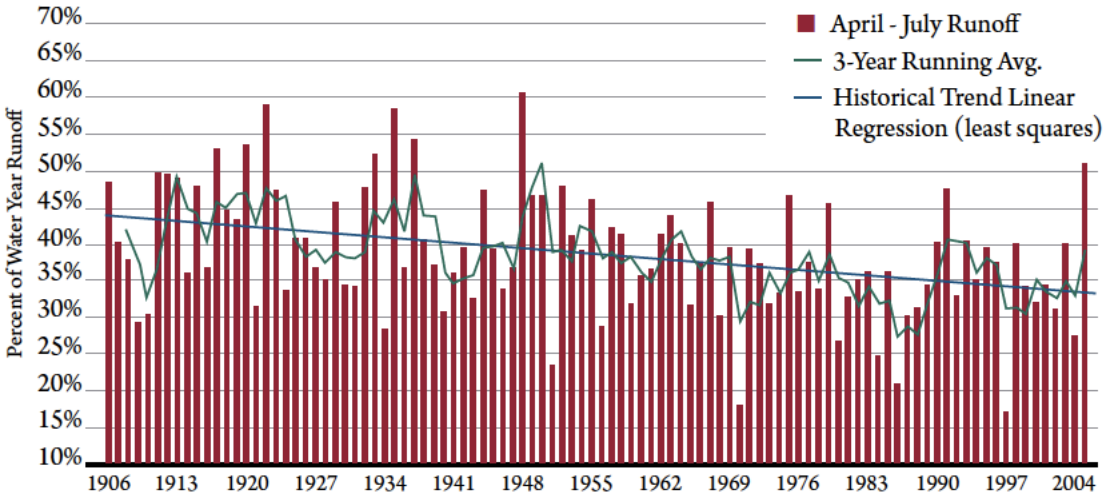

Figure 6.3. Sacramento River Spring Runoff, an indication of snowmelt, has been decreasing for years. Measured in percent of Water Year Runoff. (Source: California Department of Water Resources 2005.)

The long-term decline in spring runoff is a consequence of declining snow packs in the Sierra. As snow is so important in storing water and releasing it in spring and summer when agriculture has greatest need, the decline in snow pack has huge implications for irrigated agriculture.

Looking to the future we expect to see more of such trends. Sea level will rise with global warming and will eventually augment other threats to the Delta's levees.

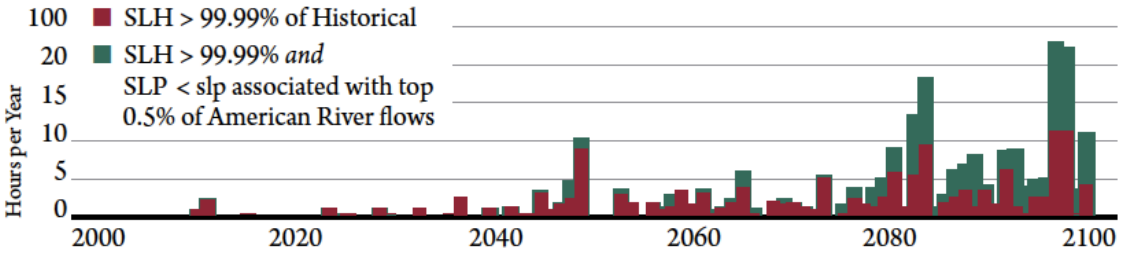

Figure 5.8. Projected increase in extreme sea levels over the next century due to global warming. SLH = sea level height. SLP = sea level pressure. These are indicators of large storm systems and high river flows. Measured in hours per year. (Source: Adapted from Cayan et al. 2007)

The figure above, from Chapter 5 in The State of Bay Delta Science, shows the projected increase in extreme sea levels due to global warming and sea level pressure variation over the 21st century. After about mid century, these extreme events become common enough to pose a major threat.

The Delta is not only variable in time, but also variable in space. Human alteration of the Delta has greatly reduced some forms of spatial variation but much remains and is very important in the Delta

ecosystem. The figure below, from chapter 4 of The State of Bay Delta Science shows temperature variation during September in the Delta.

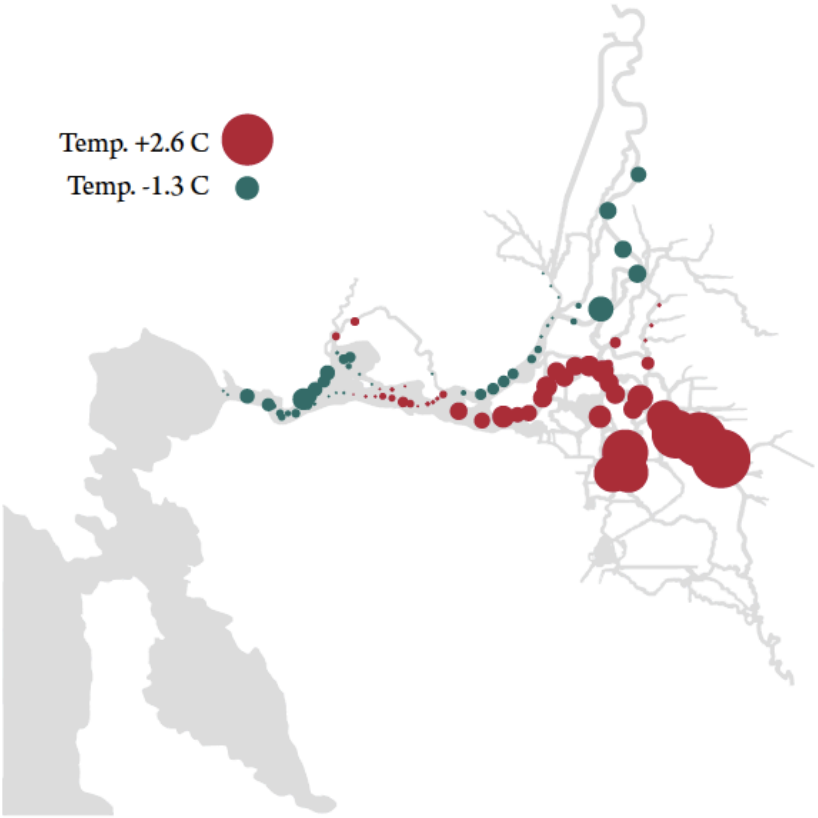

Figure 4.2. Gradient in temperature in the Delta during September based on data gathered during midwater trawl sampling from 1990 to 2001. Many other physical attributes of the Delta also show strong spatial gradients. Red dots show places where temperature was higher than the overall mean for the Delta and green dots show places where temperature was lower than the mean. The size of the dot indicates how much higher or lower the temperature was. The legend in the upper left of the figure gives a scale for the dots in degrees centigrade (i.e., -1.3 C is the lowest temperature and +2.6 C is the highest temperature). From the figure it is apparent that in September the San Joaquin is very warm and cools as it moves toward its confluence with the Sacramento whereas the Sacramento is cool and warms toward the confluence. Suisun Bay and Carquinez Strait are cooler than the Delta. (Source: Kimmerer 2004)

Other habitat variables (e.g., turbidity, salinity) show similar spatial variation in the Delta. This spatial variation in physical characteristics of the Delta determines the structure and function of biological communities. Changing conditions (climate change, population growth, changing water and land use and management) will affect patterns of spatial variation in the Delta with uncertain consequences for Delta organisms.

Other kinds of variation, such as the continual addition of new species to the Delta, also drive change and complicate management. For example, relationships that seem well established and a sound basis for management, such as the relationship between smelt abundance and Delta outflow shown below, adapted from Sommer et al 2007, can suddenly change or disappear.

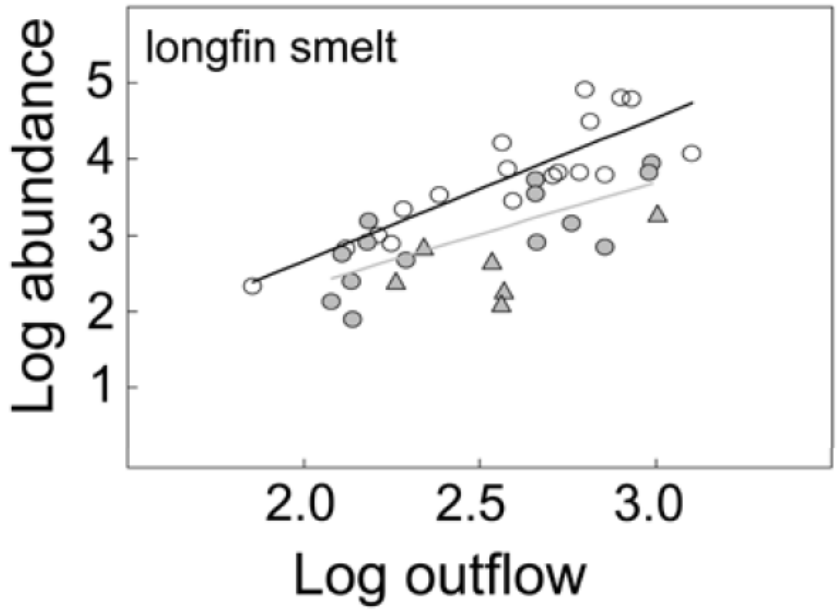

FIGURE 5. Log-log relationships between fall midwater trawl abundance indices and delta outflow for longfin smelt. Delta outflow values represent the mean levels (m^3/s) during January–June for longfin smelt. The data are compared for pre-*Corbula* invasion years (1967–1987; white circles), post-*Corbula* invasion (1988–2000; dark circles), and during the POD years (2001–2006; triangles). Fitted lines indicate linear regression relationships that are statistically significant at the P <0.05 level (Source: Adapted from Sommer et al 2007).

As shown in the figure, before 1988 there was quite a strong relationship between outflow and smelt abundance. After the establishment of the overbite clam, however, this relationship weakened and since the pelagic organism decline has become quite weak. Overall, there is still a relationship but it is much weaker and more variable than in the data from before 1988.

Such changing relationships undermine effective management, especially as they are not evident until many years after the fact, even if appropriate data are routinely collected to monitor the relationship. Such variable relationships emphasize the need for continual monitoring of the system so that change is detected early and for policies that are both robust to change and responsive to change. Adaptive management, which we will discuss briefly later, provides the tools to ensure that monitoring is appropriate and policies robust.

Wicked Problems

The variability sketched above illustrates that ecological restoration in the Delta constitutes a wicked problem. Water supply reliability, protecting the unique values of the Delta, reducing risk and improving water quality are also in varying degree wicked problems. According to Rittel and Webber (1973), wicked problems have the following characteristics:

1. The problem involves an evolving set of interlocking issues and constraints; hence, there is no definitive formulation of "the" problem. Perceptions of the problem and its causes are likely to differ dramatically among interests;
2. Since there is no definitive formulation of the problem, there is also no definitive solution;
3. Potential solutions are not right or wrong, only better or worse, and solutions tend to

reflect how different actors perceive the problem;
4. Experience with analogous problems in other contexts may not be relevant;
5. Potential solutions are costly and usually irreversible; and
6. There is no immediate or ultimate test of a solution. Rather, all solutions have successive waves of consequences and it is impossible to know how all will play out.

Problems with these characteristics are difficult not only for policymakers but also for scientists because every potential solution involves multiple and often conflicting hypotheses. Science has an important role to play in resolving wicked problems, but because there is no way to analyze all of the potential cascading consequences of any proposed solution, the consequences of policy implementation will remain highly uncertain until long after a policy is implemented. Agreement on the problems to be tackled by science or by policymakers requires negotiation among stakeholders. Core values play a central role in how different actors perceive the problem, and a collaborative approach to defining both the problem and potential solutions is essential (Weible 2006). Good science can inform the negotiation but not resolve the different perspectives. However, it is through this process of negotiation and debate that wicked problems can be made at least partially tractable and an initial direction for policy and management agreed upon.

Because the problems are wicked and evolving, however, the most effective management will be based on policies that are robust to change within a framework that is designed to continually evaluate and update both policy and management; in other words, an adaptive management framework.

Rittel, H., and M. Webber. 1973. Dilemmas in a General Theory of Planning. Policy Science 4:155–169.

Sommer, T., C. Armor, R. Baxter, R. Breuer, L. Brown, M. Chotkowski, S. Culberson, F. Feyrer, M. Gingras, B. Herbold, W. Kimmerer, A. Mueller-Solger, M. Nobriga, and K. Souza. The Collapse of Pelagic Fishes in the Upper San Francisco Estuary. Fisheries 32(6): 270-277.

Weible, C. M. 2006. An Advocacy Coalition Framework Approach to Stakeholder Analysis: Understanding the Political Context of California Marine Protected Area Policy. Journal of Public Administration Research and Theory 17:95–117.

C. Provide a separate, early chapter on Adaptive Environmental Management and elaborate on it in the contexts of subsequent chapters.

As we noted earlier, adaptive management provides the best framework for developing and implementing policy to achieve the coequal goals. There are a number of reasons for this, including scientific rigor, transparency, use of computer simulations to test the robustness of potential policies, a requirement for monitoring, and a requirement for regular updating and reassessment of the problem, the policies and the management program. We were pleased to receive at our meeting, the draft of Chapter 4, which deals with adaptive management, and will comment on it at the next ISB meeting. However, we understand that there is a proposal to eliminate the chapter dedicated to adaptive management and disperse discussion of adaptive management throughout the Plan. We feel that would be a bad approach. A discussion of how adaptive management should be employed for each major

aspect of the plan (water supply, ecosystem, water quality, risk, Delta as place) should be included in each chapter, but adaptive management is so important to the overall success in achieving the coequal goals that the framework should also be fully described in a dedicated chapter.

Adaptive management demands certain kinds of science if it is to function successfully in addressing complex "wicked" problems. These include: insightful analyses of a very broad array of relevant data to inform the debate about problem definition; development of conceptual and simulation models of the system that can be used to explore the consequences of both alternative conceptualizations of the problem and potential policy alternatives; rigorous design of monitoring to maximize the potential for learning from policy implementation and timely analysis of monitoring data to ensure that conceptualization of the problem and policies can be updated efficiently. This degree of integration of science into policy is not commonly practiced. Typically science is poorly integrated into the problem formulation and policy development process, new science is conducted largely independent of policy and management and the potential for management actions to generate new data is little utilized; monitoring programs are poorly planned and underfunded; and problem formulation and policy are updated at time of crisis. If the Delta Plan is to be successful, we feel it must promote a much closer integration of science and policy. For this to happen, both policy-makers and scientists will need to set aside their standard operating procedures and explore new ways of working together.

II. Overall suggestions on the preparation and presentation of the Delta Plan.

A. Reduce and transform the findings to problem statements with policy implications. The inconsistent nature of what are presented as findings makes the first draft nearly unintelligible. Future drafts need to be logical and consistent. In the next section we provide some specific examples of how what are currently expressed as findings can be converted into problems with policy implications.

B. Cite comprehensive syntheses document when available. A number of reports published recently summarize much of the best scientific information on the Delta relevant to the coequal goals. These synthesis documents should be core references for the development of the Delta Plan. Because these synthesis documents are well referenced, they provide a critical link to the broader scientific literature about the Delta and related systems.

Although these synthesis documents and overview reports, such as the 20X2020 report and the Delta Risk Management Study (DRMS), are extremely important in plan development, the consultants drafting the plan will often have to go deeper into the scientific literature. Reports such as the PPIC documents, together with powerful search engines such as Google scholar, can point the Plan drafters to relevant authors and references.

CALFED Reports

Michael Healey, Michael Dettinger, and Richard Norgaard (ed.) 2008. The State of Bay Delta Science, 2008. CALFED Bay Delta Program.

Agency Reports

Randall Baxter, Rich Breuer, Larry Brown, Louise Conrad, Fred Feyrer, Stephanie Fong, Karen Gehrts,

Lenny Grimaldo, Bruce Herbold, Peter Hrodey, Anke Mueller-Solger, Ted Sommer, and Kelly Souza. 2010. Interagency Ecological Program 2010 Pelagic Organism Decline Work Plan and Synthesis of Results. Interagency Ecological Program for the San Francisco Estuary.

PPIC reports:

Ellen Hanak, Jay Lund, Ariel Dinar, Brian Gray, Richard Howitt, Jeffrey Mount, Peter Moyle, and Barton "Buzz" Thompson. 2011. Managing California's Water: From Conflict to Reconciliation. Public Policy Institute of California

Jay Lund, Ellen Hanak, William Fleenor, William Bennett, Richard Howitt, Jeffrey Mount, and Peter Moyle. 2008. Comparing Futures for the Sacramento-San Joaquin Delta. Public Policy Institute of California.

C. Use primary sources whenever appropriate, including sources that are not in complete agreement with each other. There are an amazing number of publications by state and federal researchers, university faculty, and nongovernmental scientists. Many of these are published in *San Francisco Estuary and Watershed Science*, the journal historically supported as a part of CALFED and now as part of the activities of the Delta Stewardship Council. Numerous other journals in which Delta science is published can be readily accessed electronically. The Delta Plan offers an opportunity to apply the findings of highly dedicated researchers over the past quarter century.

D. Use illustrations extensively. Illustrations save words, frequently convey complex information more effectively, and break the tedium of text. The Delta ISB highly recommends that graphical information be used in subsequent drafts and that those tasked with working with the visual display of information become involved in the process as soon as possible.

E. Define terms and use them consistently. The glossary needs to be expanded to include words such as "water supply reliability" while terms such as "efficiency" with different meanings (engineering, economic, energy) need to be better elaborated in the text.

F. Prepare the Plan as an educational document. The Delta Plan should be an important educational document, a communication of the best available science and how this affects Delta policy and management. It certainly should not leave existing public misconceptions in place.

III. Specific Suggestions for Improvement

The following suggestions for improvement were initially provided by individual board members, elaborated in small group discussions, and brought to the attention of, and in some cases discussed by, the Delta ISB as a whole. Some of the suggestions provide specific evidence of a general problem elaborated in Sections I and II. Other suggestions have not been refined as they might be or agreed to by the Board as a whole but are provided in this review as ways to think about improving the draft. The inconsistency in the style and formatting reflect the multiple origins of this material.

Chapter 5 – Manage Water Resources

The draft Water Resources chapter touches on most of the important issues but needs overall improvement in several respects:

(1) The findings need to flow from and agree with their supporting documentation. Under several findings, the Plan's narrative does not support the finding, differs distinctly from the Basis of Finding, or both.

(2) Each finding should be worded as a problem statement that sets up remedial action. In the current draft, some of the findings are statements of fact, while others are statements of policy, and still others are recommendations for future policies.

(3) Key terms should be defined at the outset and used consistently. Does *water efficiency* denote the same concept as *efficient use of water* and *water use efficiency*? Does the *efficiency* refer to economics, meeting the coequal goals, or reducing total water use? Performance measures of *water supply reliability* will depend on its definition. What does *sustainable* mean?

(4) The chapter needs to communicate and reckon with the inherent variability of climate in California, of populations of native species, and of the ecosystems they rely on. How will this natural variability impact water supplies for humans and other species? How will adaptive management adapt to it?

(5) The Plan should reflect the coequal goals by treating water supply as integral to ecosystem health and restoration. The two could be brought together in future drafts of this Water Resources chapter, of the Plan's final chapter, or both.

(6) Several of the findings need support from diagrams that would convey, at a glance, numerical information that makes the existing text hard to read. Time series of historical changes could provide helpful context if extended back into the early 20th century or even before.

Objective: PROMOTE A MORE RELIABLE WATER SUPPLY

Finding: CALIFORNIA'S TOTAL WATER SUPPLY IS FINITE
Unless California determines how to expand its share of the Colorado River or significantly increase desalinization, this statement is correct. However, within the justification for this finding, the statement is made that California "regularly uses more water annually than is provided by nature." This is misleading and should be reworded.

It is more accurate to state that within the interconnected network of California's water supply system, of which the Delta is a key hub, some regions are using more water than can be sustainably supplied over the long term. Foremost of these regions is the Tulare Basin, where annual water deficits are 1-2 MAF or more and are depleting local groundwater reserves.

Also, as stated, the finding does not point to an action, nor does it clearly address the objective of promoting a more reliable water supply.

Notes on *Basis of Findings.* The Basis of Findings presents a confusing summary of where water comes from and its various consumptive uses. It singles out 2000 as a "normal" year as an example (it wasn't: by definition there is no such thing). If the summary's point is that we are using more water than we have, the estimate is wide of the mark.

As an example, roughly 40 percent of the runoff in the state occurs in the North Coast where it is unavailable for human uses. The remainder of the runoff (approximately 43 MAF) occurs within regions outside of the North Coast and is used consumptively for human and environmental uses. To support agriculture and urban development in the state, there are extensive transfers of water and use of groundwater. On an annual average basis (1998-2005), consumptive use of water for human and environmental uses is approximately 42 MAF in this interconnected network, roughly equal to the water supplied by runoff. However, 4 MAF of this total comes from the Colorado River and not from runoff within the state. Thus, only 38 MAF of the unimpaired runoff outside of the North Coast is used consumptively.

A better approach to this would be to highlight the fact that some regions have abundant water supplies (North Coast, Sacramento), while most regions do not. It is in these latter regions, such as the Bay Area, South Coast, San Joaquin and Tulare Basin, where demand for water is highest, and local supply is the least. In some of these regions, such as the Tulare Basin and parts of the Central and South Coast, consumptive use exceeds available local supplies and regional transfers, leading to groundwater overdraft and increasing water scarcity. Because California's water is interconnected, high scarcity in one region can impact other, more water-rich regions.

Finding: CALIFORNIA'S WATER INFRASTRUCTURE IS INCREASINGLY VULNERABLE TO EXTERNAL FACTORS SUCH AS CLIMATE CHANGE

The justifications provided for this statement do not address vulnerability of the system, per se. Rather, the justification focuses more on how changing conditions are likely to outstrip the ability of infrastructure to manage supply and flood risk. This is different than vulnerability. The system will always be able to manage supply and floods, albeit less effectively with time. This is, admittedly, a semantic argument, but vulnerability implies that the system will "break" when in reality it will simply underperform.

Perhaps the finding could better reflect the justification by stating that "California's aging water management infrastructure is incapable of meeting present and future demands for flood control and water supply." The current justification lacks a sufficient explanation about how changes in demand—agricultural, urban, and environmental (post 1970's)—have played a central role in this problem.

Alternatively, the finding itself could be reworded to state that "California's outdated water management infrastructure is increasingly vulnerable to changing conditions, including climate change, earthquakes, sea level rise and declining ecosystems." This would require a different justification than the one used in the body of the Plan, but would fit more closely with the Basis of Findings sheet.

Notes on *Basis of Findings.* The first paragraph states that climate change is having a profound effect on water resources. It then lists climate changes, along with some climate events (severe droughts). First, the text does not make an explicit connection between climate change and the profound effects it is having on California's water resources (or flood management). Second, certainty that the droughts and wets of southern California are related to global climate change is low. These events have to be part of a long-term trend linked, through the use of General Circulation Models (GCM's), to climate change. Otherwise, they are just a natural phenomena associated with California's Mediterranean climate.

The second paragraph also gives a laundry list of effects, many poorly-linked to their impact on water supply or flood and ecosystem management. This entire Basis of Findings would be more effective if it was done as a narrative that addresses the finding, rather than a list.

Finding: THE CONSTITUTION OF CALIFORNIA REQUIRES THAT WATER BE USED FOR BENEFICIAL PURPOSES, THAT WATER BE USED REASONABLY, AND THAT NO WASTING OF WATER SHALL OCCUR.

This is an accurate statement of fact. But it is not clear how it relates to the Objective. Moreover, it is not presented as an actionable problem.

Finding: CALIFORNIA'S WATER SUPPLY IS PROVIDED BY LOCAL, REGIONAL, STATE AND FEDERAL DAMS, RESERVOIRS AND CONVEYANCE SYSTEMS. HOWEVER, IMPROVED REGIONAL WATER SUPPLY SELF-RELIANCE IS ONE OF THE MAJOR WAYS WE CAN MEET OUR COEQUAL GOALS OVER THE COMING DECADE.
Perhaps the first sentence of this finding could be dropped. It is a statement of the obvious, even though it leaves out groundwater. It is important to note that this finding is more a statement of policy rather than a salient fact about conditions or law. It also is not set up as a problem statement that is actionable.

Note on *Basis of Finding.* Again, this provides a laundry list rather than an analysis that explains the finding.

Finding: SURFACE AND GROUNDWATER SUPPLIES WILL ONLY BE RELIABLE ON A LONG-TERM BASIS IF GROUNDWATER OVERDRAFT IS ELIMINATED.
Groundwater overdraft does not affect water supply reliability for the entire state, just those basins where it occurs and where overdraft increases demand for transfer of water from other basins. However, as stated here and in the Basis of Findings, it is generally true that reducing or ending sustained groundwater overdraft is both appropriate and necessary for sustainable water management. This finding should be rewritten to describe a problem that is actionable.

Objective. PROMOTE STATEWIDE WATER CONSERVATION, WATER USE EFFICIENCY AND SUSTAINABLE USE OF WATER

Finding: URBAN RESIDENTIAL WATER USE HAS NOT DECLINED FOR THE PAST 40 YEARS. AGRICULTURAL WATER USE HAS CONTINUED TO BE AT THE SAME STATEWIDE LEVEL OF APPROXIMATELY 33-34 MAF PER YEAR FOR MANY YEARS. WHAT REMAINS OF THE AVAILABLE WATER SUPPLY IS OFTEN CALLED ENVIRONMENTAL WATER. WITH POPULATION GROWTH AND LITTLE CHANGE IN WATER EFFICIENCY, CALIFORNIA'S WATER DEMANDS WILL CONTINUE TO INCREASE.
This statement appears overly specific as compared to other findings. It is accurate to state that: "With population growth and little change in water use efficiency (define), California's water demands will continue to increase." The rest of the finding is not necessary.

The narrative, as contained within the Delta Plan is both wrong and, in some cases, not germane to the finding itself. Based on a variety of sources cited in Hanak et al (2009, 2011), there are several key trends. Overall gross use for agriculture has gone down, not up, since its high in the 1990s. Per capita

water use in California has also gone down, significantly in many areas. It has gone down so much that gross urban water use has remained flat for the last 15 years, despite significant increases in population. Current trends are for a reduction in human uses of water in California.

Notes on *Basis of Finding.* The Basis of Finding has many of the same problems as the narrative contained within the Plan. It fails to account for positive trends in water use.

Finding: WATER CONSERVATION IN ALL SECTORS CAN BE SIGNIFICANTLY IMPROVED.
The finding, as stated, is a proposed policy, not an actionable problem statement. The explanation of the finding is essentially a redaction of the policies adopted in the 20x2020 Water Conservation Plan. It should be noted that this plan focuses principally on reductions in urban water use through conservation plans and largely ignores agricultural water use. This does not square with the blanket statement of the finding.

There is debate over how much water conservation in the agricultural sector actually yields. Many studies have shown that conservation, typically involving new technology, does not lead to a decrease in net water use (see discussion in Hanak et al., 2009, 2011). This stems from the fact that "new" water created by conservation usually is used to grow more crops (increasing losses to evapotranspiration), rather than being lost to groundwater or surface water. The fundamental challenge is how to manage water created by agricultural conservation.

There is no debate that water conservation in the urban sector can be improved, with considerable benefit.

There has not been an extensive examination of the role of water conservation for environmental applications, but this finding appears to indicate that it is necessary. Does the Council mean that?

Notes on *Basis of Finding.* The Basis of Finding merely repeats the policy statements of the 20x2020 Water Conservation Plan and does not make the case for water conservation.

Finding: REUSE OF WATER, RECYCLING, GROUNDWATER MANAGEMENT, STORMWATER CAPTURE, TREATMENT AND REUSE OF IMPAIRED WATERS AND SEA WATER DESALTING IS [ARE ALL?] VITAL TO IMPROVING THE OVERALL RELIABILITY OF CALIFORNIA'S WATER SUPPLIES, BUT IS [ARE?] NOT LIKELY TO BE [A] MAJOR FACTOR[S] FOR SEVERAL DECADES OR MORE.
This finding sets out policy, rather than identifying an actionable problem.

There is the implication that improvements in water management are several decades away. But with the exception of desalinization, all of these practices are currently being used aggressively in some regions, particularly the South Coast.

This finding should be merged with others that promote the use of portfolio approaches to water management that diversify water sources to the maximum extent possible.

Objective: PROMOTE OPTIONS FOR NEW AND IMPROVED WATER CONVEYANCE, STORAGE SYSTEMS, AND OPERATIONS OF BOTH TO ACHIVE THE COEQUAL GOALS.

Finding: MANY OF CALIFORNIA'S WATER SUPPLY FACILITIES WERE INITIALLY PLANNED AND DESIGNED BASED ON CONDITIONS IN THE LATE 1800S AND EARLY 1900S, AND FACILITIES MAY REQUIRE MAJOR REPAIRS DUE TO AGE.
There seems to be a disconnect between the finding and the narrative that follows, along with the Basis of Finding sheet. The comment about historic hydrologic conditions that formed the basis for water supply facilities design implies that there is a difference between the conditions that guided design and those of today. These are not mentioned in the basis for findings.

If the intent of this finding is to highlight the age of infrastructure and the need to invest in maintenance and operations as well as upgrading facilities, then that should be stated clearly. If it is to imply that the facilities are under-designed due to changes in hydrologic conditions, then that should be stated (it is not in the findings). If the latter, it is covered already in the second finding.

Finding: STATE WATER PROJECT LONG-TERM AVERAGE WATER DELIVERY RELIABILITY HAS DECLINED SUBSTANTIALLY IN THE PAST SEVEN YEARS
This has another disconnect between the finding, the narrative and the Basis of Finding. Why the choice of *seven years*? Does it correspond to *long-term*? Also, why single out the SWP? Why not focus on water supply reliability in general related to the Delta (SWP and CVP), and take it back to the 1980's or earlier? The focus on the last seven years could be viewed as arbitrary selection of a baseline condition that helps make the case that environmental laws are the sole cause of the decline. In addition, the finding ignores the fact that groundwater makes up the difference in years of drought.

Finding. STORAGE CAPACITY MUST BE INCREASED AND RESERVOIR OPERATIONS MODIFIED TO IMPROVE WATER SUPPLY RELIABILITY.
This should be reframed as an actionable problem statement. This statement also leaves out the all-important concept of conveyance as necessary to realize this increase in reliability. Conveyance remains the number one bottleneck in the Delta.

Note on *Basis of Findings*. This is more a recitation about policy established in Delta Vision and the 2009 legislation package than an actual support for the finding.

Finding: CONVEYANCE MUST BE CHANGED AND RE-OPERATED TO IMPROVE WATERSUPPLY RELIABILITY

This should be combined with the above and defined as a single problem statement. Additionally, the basis of finding only repeats existing policy, rather than providing a basis.

Finding: LOCAL STORAGE PROGRAMS CAN IMPROVE CAPTURE AND SUBSEQUENT USE OF STORMWATER FLOWS, AND POSSIBLY DRY WEATHER RUNOFF, TO INCREASE WATER SUPPLIES

This should be combined with the finding on improving regional self-sufficiency and should be reworded to establish an actionable problem.

Notes on Basis of Findings. The Basis of Findings seems to focus exclusively on Metropolitan Water District. This is odd, since it is the Bay Area that does a much poorer job of managing urban water runoff efficiently. This should be more balanced, since the Bay Area draws the same amount of Delta water as MWD, and if you count diversions upstream of the Delta, even more.

Objective. MEASUREABLE ASSESSMENT OF WATER SUPPLY RELIABILITY IMPORTED FROM THE DELTA WATERSHED

Finding: MANY LOCAL, REGIONAL, STATE, AND FEDERAL AGENCIES AND ORGANIZATIONS COLLECT WATER DATA, BUT USE DIFFERING METHODOLOGIES AND LEVELS OF DETAIL WHICH SEVERELY LIMITS THE USEFULLNESS OF THE INFORMATION
This is a well-established fact. No comments.

Finding: TO BETTER UNDERSTAND AND TRACK THE WAYS WATER IS USED IN THE URBAN, AGRICULTURAL AND THE ENVIRONMENTAL SECTORS, A RIGOROUS, MANDATORY STATEWIDE WATER DATA COLLECTION AND ANALYSIS PROGRAM IS NEEDED
This could be simplified by combining it with the preceding finding and making both an actionable problem. This issue has been noted in numerous publications from agencies, foundations, universities and more. Yet policy remains far behind on this, particularly due to the failure of the 2009 legislative package to compel monitoring of groundwater use.

Notes on Basis of Finding. The focus on 20x2020 standards is appropriate, but there should be an emphasis on agricultural and environmental standards as well. This is touched on in the second section, but is not sufficiently fleshed out. These seemingly disconnected sections should be combined into a single narrative.

Chapter 6 Restore Delta Ecosystem

General comments

The citations in the Findings Fact Sheets are overly reliant on state reports rather than peer-reviewed literature when it is available. The latter would provide stronger support for the scientific credibility of the findings. The Plan itself may mainly cite summaries of the available literature, such as the PPIC reports or the State of Bay Delta Science report, but the Findings Fact Sheets should cite original literature where possible, especially peer-reviewed syntheses. The citations should be placed in the text where the statements they support are made, so that specific statements can be more clearly linked with specific literature. Chapter 4 on adaptive management provides a good example of using this approach.

Although the Plan and Findings Fact Sheets are not the appropriate places for exhaustive reviews of relevant work that has been done elsewhere, where appropriate a brief background or summary statement of such work should be provided to indicate that the breadth of scientific support for a Finding extends well beyond the specific studies conducted in the Delta. The importance of establishing natural flow regimes to enhance the functioning of aquatic ecosystems is an example of a finding supported by research done on rivers throughout the world.

We are concerned that some Findings are missing in this chapter. In addition to Findings bearing on terrestrial ecosystems (mentioned below), the impacts of hatchery management practices on native fish species, upstream habitat management (e.g., providing spawning habitat for salmon and steelhead), and habitats affected by aqueducts and storage facilities for exported water should be addressed.

The chapter presents many impediments for restoration, but does not do a good job of clarifying why the Delta needs to be restored and to what condition it needs to be restored. A definition of and vision for restoration is lacking. The Plan states what restoration is not trying to do (i.e., not restore to historical conditions), but is less clear about what it is trying to do; the vision for what is meant by a restored Delta ecosystem is not clear. Restoration is not adequately defined. Restoration requires a specification of clear objectives and targets, but specifying such targets in a changing and uncertain future is difficult. Fixed targets for restoration efforts are likely to be inappropriate. A fuller appreciation of the restoration ecology literature is warranted.

The focus in this chapter is on aquatic ecosystems; fuller attention needs to be paid to terrestrial flora and fauna. Terrestrial systems are mentioned in the chapter on Delta as Place, where impacts of agricultural practices are discussed; however, recognition of terrestrial ecosystems belongs in chapter 6 as well. Riparian ecosystems and exchanges between terrestrial and aquatic systems are certainly affected by the changes in the aquatic ecosystems described in this chapter, and the dynamics and ecological functioning of aquatic systems are influenced by the broader riparian and landscape surroundings. Findings should address elements of the terrestrial systems and the aquatic-terrestrial interactions that are integral to the functioning of the Delta as a whole.

In discussing the importance of complexity and diversity the chapter does not recognize the significance of landscape structure; the size and arrangement of habitat units, whether aquatic or terrestrial, is extremely important to the overall functioning of the Delta ecosystem.

Some of the language used in the introductory statements is excessive or ecologically incorrect. For example, in paragraph 2, L 9-19; some statements need rethinking: “The Delta and Suisun Marsh ecosystem, was once one of the most biologically productive and diverse ecosystems on the west coast.” The Delta still is one of the most productive and diverse ecosystems on the west coast, but it no longer produces some of the species that were historically important in the ecosystem. “The Delta ecosystem is… in peril.” This is misleading. What is in peril are elements of the ecosystem and some patches of the ecosystem mosaic. Avoid the euphemism of “reclaim farmland.” No farmland was reclaimed. Farmland was created by diking and draining wetlands. “The Delta has been modified in ways that adversely influence ecosystem function and compromise its ability to support a healthy ecosystem.” Again, caution is needed with language here. Delta modification has changed ecosystem function to the detriment of some species and community types. The ecosystem is just not producing the kinds of services that humans find most desirable at present.

Restore or protect habitat

1. Habitat extent and complexity have been substantially eliminated in the Delta and Suisun Marsh. The term “substantially eliminated” is too strong; “significantly reduced” would be more accurate.

This finding is very qualitative and could be strengthened by more quantitative information such as acres of tidal marsh and floodplain wetland habitat that have been lost and miles of channel that have been eliminated. The maps are striking and give the reader a sense of change, but the magnitude of change is not quantified. There is no mention of loss of connectivity to terrestrial ecosystems. The Fact Sheets could evaluate the extent and impact of these changes in different parts of three different Delta landscapes: flood basins (North Delta), tidal islands (Central Delta), and distributary rivers (South Delta). Those landscapes are based on current work on historical landscapes being done by the Aquatic Science Center (Grossinger et al. and Greiner citations below).

The general statement that resiliency is promoted by extensive and structurally diverse habitats is based more on conventional wisdom than on actual evidence. More relevant statements would consider how much habitat heterogeneity is enough; how much is too much? There are not simple answers to these questions, which is further justification for why adaptive management is essential in this ecosystem. Habitat complexity will favor certain species as has been demonstrated in the Yolo bypass and Cosumnes floodplain.

Grossinger, R., Whipple, A., Rankin, D. & Collins, J. Historical Delta habitat mosaics: conceptual models for building a diverse and resilient future Delta. Oral Abstracts, Bay-Delta Science Conference, September 27-29, 2010, http://www.baydeltascienceconf.com/sciconf2010/?q=node/414 (2010).

Greiner, C. M. Principles for strategic conservation and restoration. Puget Sound Nearshore Ecosystem Restoration Project Report No. 2010-01. 40 p. http://www.pugetsoundnearshore.org/technical_papers/conservation_and_restoration_principles.pdf (2010).

2. The Delta ecosystem is irreversibly changed.

This finding is not framed as a problem statement. It should state why the fact that this system has been irreversibly changed is a problem. If restoration to a previous state is not possible, what should the goals be, and how should they be determined? It should be noted that the idea that the Delta has gone through a regime change is controversial. The idea is put forth in the 2010 POD workplan but has not received formal scientific review.

The term ‘regime shift’ should be defined (here it is used to mean an alternative stable state). In our experience ‘regime shift’ often refers to a periodic (sometimes decadal) shift in a system attributable to climate factors (e.g., Pacific Decadal Oscillation). Differentiate between regime shift and a shift in the ecosystem to a different state from which reversibility may be difficult or impossible (as visualized in state and transition models).

Some elaboration of the “important ecosystem processes” that have been “disrupted” would improve this finding. One place where this has been reviewed and the ecosystem processes described is Kimmerer et al. 2008. Aquatic ecosystems. pp. 73-102 in Healey, M.C., M.D. Dettinger, and R.B. Norgaard (eds.) The State of Bay Delta Science.

3. Natural ecosystems seldom conform with political boundaries or land ownership patterns.

This Finding needs to be recast as a problem statement (e.g., this constrains our ability to deal with ecological problems). There is a mismatch between the scale at which ecological solutions are needed and political boundaries and land ownership patterns. It is this mismatch that creates problems that must be addressed in the Plan.

What does "leverage historical landscape features" mean? Some of us thought it meant target restoration actions adjacent to remnant landscape types (e.g., next to a remnant marsh); others thought it meant target areas that used to have particular landscape features (e.g., used to be a marsh).

The Suisun Marsh example in the Findings Fact Sheet is illustrative, but further discussion of this concept on the scale of the Delta as a whole (e.g., for different regions of the Delta) would again help focus thinking about restoration efforts in different regions. This would also be a place to talk about watershed impacts, i.e. upstream changes that have influenced the Delta. Watersheds are a striking example of natural ecosystems that cross many political and land ownership boundaries.

4. The processes for obtaining project-specific permitting and authorization are not well coordinated, which could delay progress on ecosystem restoration.

This is an issue of policy and governance but not science. It is actually a larger issue than its impact on habitat restoration. It affects the ability to do research and monitoring (e.g., the need to get permits) and is a constraint on implementing adaptive management. Even if all the science is "the best" and the recommended actions have real potential to address the problems, it may all come to naught, or come too late, unless the process is streamlined. Addressing this issue belongs in the governance section.

5. The current scientific infrastructure and expertise are not sufficient to support the science and adaptive management needed for successful ecosystem restoration.

The Delta has an impressive amount of scientific expertise, so it is not accurate to say that the expertise is not sufficient. The expertise is currently not adequately coordinated to support adaptive management. Furthermore, the stability of a funding base to support that expertise is not present.

We were not provided with a Findings Fact Sheet for this. The Fact Sheet for the previous Finding was repeated.

6. Even with substantial restoration efforts, some native species may not survive.

Some revision of this finding is needed: "are not likely to survive" would be more accurate than "may not survive." Despite our best efforts, given the large-scale irreversible changes that have occurred and external forces such as climate change, some species are not likely to survive. Several factors contribute to this grim conclusion, but two are of primary importance. First, during the coming decades the combination of climate change, land-use change, and increases in numbers of invasive species will create so-called "no analog" environments and biological communities. Management efforts based on factors that stress populations of native species now may be ineffective in dealing with these future

changes, and some species that are currently at risk (as well as others that are not) may simply be unable to cope with the changing conditions, no matter how heroic the management efforts. Second, management and restoration require resources, yet the number of species and ecosystem elements requiring some form of active management or intervention to persist is distressingly large. These are what Scott et al. (2005, 2010) have termed "conservation-reliant" species. Few of these species are now receiving adequate attention, and future environmental changes are likely to swell the ranks of such conservation-reliant species.

This does not mean that the game is over, or (as the finding correctly notes) restoration is unnecessary. It does mean that careful efforts should be undertaken to prioritize the targets for conservation or management action, based on a realistic cost-benefit analysis of the likelihood of success (i.e., long-term population viability) in relation to the resources required. But, given the uncertainty of future conditions and how species will respond, how is this prioritization to be accomplished? Perhaps more important is to have made some a priori decisions about levels of investment in individual species conservation. Maybe also include here the idea that the Delta may become a refuge for species that cannot cope elsewhere but could survive in the Delta and that Delta species might be reestablished elsewhere where conditions remain favorable. Criteria for deciding when to attempt to reestablish species also need to be developed, keeping in mind that any introduction is likely to have unintended consequences.

This Finding also points to the need to move to ecosystem-based management. Species are in crisis because of loss of ecosystem structure and function, so adjustments to ecosystem structure and function are needed.

Scott, J.M., D.D. Goble, J.A. Wiens, D.S. Wilcove, M. Bean, and T. Male. 2005. Recovery of imperiled species under the Endangered Species Act: the need for a new approach. *Frontiers in Ecology and the Environment* 3: 383-389.

Scott, J.M., D.D. Goble, A.M. Haines, J.A. Wiens, and M.C. Neel. 2010. Conservation-reliant species and the future of conservation. *Conservation Letters* 3:91-97.

Water Quality

1. Restoring a healthy ecosystem may require developing a more natural salinity regime in parts of the Delta.

This Finding is not a statement of the problem. A statement of the problem is in the final sentence of the explanatory paragraph after this Finding: "the altered salinity regime has created conditions that adversely affect native species adapted to a more variable salinity regime and favor exotic species." The question that must be addressed ultimately is what does a "more natural salinity regime" represent? It's easy to say that the system has lost its natural dynamics; it's quite another to say what, exactly, should be restored. How much salinity, in what places, how often? To be useful, subsequent drafts of the Plan or its supporting documentation should tackle this issue.

This Finding could be incorporated with the finding on establishing a more natural flow regime, as salinity variation and flow regime are closely connected. Furthermore, salinity variation is also connected with channel complexity and the proposed reestablishment of dendritic geometry.

2. Contaminants discharged from municipal, industrial, and agricultural sources directly or indirectly into the Delta have affected native species by altering food webs, reducing food web productivity, and producing toxicity.

This Finding is more appropriate in the water quality chapter.

This Finding inappropriately combines many types of contaminants from a variety of sources. This is a problem because the potential policy responses differ greatly depending on the nature of the contaminant and its source. Moreover, it focuses on 'discharges', which minimizes non-point sources. Also, the direct impact of contaminants on food webs and productivity is controversial and confounded by the large effect of introduced species.

Promote viable populations of native resident and migratory species

The awkwardness associated with organizing the document by statutes is particularly apparent in this section.

1. Flood management above the Delta and the Delta margins has substantially reduced the habitat for native species that use floodplains.

This belongs in the habitat section. These issues of flood management are also relevant within the Delta. Both riverine and estuarine margins are important ecotones upon which species depend.

There is a large literature pointing out the ecological values of floodplains in river systems throughout the world. Because the Delta has been so heavily engineered, restoring ecologically functioning floodplains is an engineering challenge, but it is also an opportunity. What is needed is to determine which places should be flooded, when, for which species, and how this can be orchestrated with the other multiple demands on water flows in the Delta (Moyle, 2007). It is an optimization problem.

Moyle, P.B., P.K. Crain, and K. Whitener (2007), "Patterns in the use of a restored California floodplain by native and alien fishes," *San Francisco Estuary and Watershed Science* 5(3): 1-27.

2. Most floodplains in the Central Valley lack connectivity with the rivers to the detriment of the ecosystem.

This should be combined with the previous Finding, which is what was done in the Findings Fact Sheet.

Establish migratory corridors

1. Current instream structures (e.g., dams, weirs, and gates) impair local and migratory movement of native resident and migratory species in the Delta and upstream reaches.

Levees also restrict movement as do the culverts associated with highways and roads. Causeways for highways and other infrastructure criss-crossing the Delta also affect the movements of terrestrial

species and lead to habitat fragmentation.

Reduce threats and stresses

Here is another place where the awkwardness of the current structure (i.e. by reference to specific statutes) is apparent. All of the previous findings relate to threats and stresses. It is ludicrous to imply that these are the only two that relate to reducing threats and stresses.

1. Introduction of exotic plant and animal species has degraded the quality of habitat in the Delta.

Not every exotic degrades habitat quality. Ecosystems are altered to the detriment of desirable native species; they are not necessarily degraded. Non-native species have disrupted food webs and damaged habitats for preferred species. The presence of exotic species imposes constraints on the ability to restore, enhance, and protect native species. Non-indigenous species will continue to enter the system, although we can do things to reduce the rate of introduction. There is a need to prioritize actions on invasives, recognizing that some invasives are benign, others have become established over time as parts of the current ecosystem, and others have the potential to throw ecosystem functions into disarray. Consideration also needs to be given to actions aimed at early detection and eradication as it is very difficult to identify a problem invader before it becomes a problem. The important thing to realize is that not all invasive, exotic species are equivalent in their effects on native species or ecosystem functioning.

2. Entrainment at water diversions in and upstream of the Delta adversely affects native aquatic species.

This Finding is accurate, specific, and expressed as a problem statement. It illustrates how we think findings should be crafted.

Provide a more natural flow regime

1. Current flow regimes harm native species and encourage non-native species through their effects on turbidity, salinity, aquatic plant communities and nutrients.

The effect of altered flow is considerably more than has been listed: loss of habitat, loss of regular flooding, changing riparian and floodplain species composition, and loss of habitat-creating flows. This is not something unique to the Delta but has been well documented around the globe, and that literature should be acknowledged. Citing literature from outside the Delta can strengthen the scientific basis for findings.

2. Climate change has altered and will continue to alter flow regimes.

Climate change will alter far more than flow regimes. All aspects of climate change will affect and impose constraints on the coequal goals. When discussing the impact of climate change, it is important to consider the longer record of climate change in the region, not simply the historical record of climate and scenarios of change.

Chapter 8 – Reduce Risks to People, Property, and State Interests

The comments below deal first with suggestions for the chapter's title and introduction, then with individual findings identified in italics. Appended at the end are annotated references to studies from the Delta Risk Management Strategy, to a pair of successive estimates of California earthquake probabilities, and to two recent papers on sea-level rise.

TITLE AND INTRODUCTION

- The title could express the coequal goals by including ecosystems – and species additional to ours – among the "state interests" at risk. Supporting text in the chapter could explore the consequences, for ecosystems, of levee failure.
- This chapter could begin with an overview of the main sources of hazard in the Delta, and with an overview of what the hazards threaten. The product of these two things – probability x consequences – could be stated as the definition of "risk".
- The hazards that drive levee failure could be listed and, if possible, ranked by importance. The list could include floods, increase in flooding as sea level rises and if storms intensify, wind waves, earthquakes, subsidence, poor levee foundations, poor construction, animal burrows, and errant ships.
- New projections of sea-level rise commonly exceed 1 m by the end of the 21st century. The report could cite several such projections. Examples in the reference list below.
- A map accompanied by a table or graph could help demonstrate the levee-failure risk by showing the history of Delta levee failures (plot sites on map, and tabulate or graph by date and cause). In this map, or in an accompanying one, illustrate the modern assets at risk – farms, natural-gas wells, highways, real-estate developments, pipelines, water-project facilities. Also identify, on this map, ecosystem features that would be endangered by flooding of many islands.
- Additional maps: Who's responsible for which levees: federal, state, local. Levees coded by susceptibility to earthquake-induced failure according to Figure 6-37c of the 2008 DRMS final report.
- The Plan's preparers could consider how The New York Times uses such maps and diagrams. They can stand alone in telling a story that the text cannot do effectively or concisely. The illustrations, if of high quality like those in "The State of Bay-Delta Science 2008", can serve to draw the reader into the report.
- With such background in hand, the reader would be better prepared to consider levee-risk reduction by means of emergency preparedness, levee improvement or abandonment, and infrastructure protection.

FINDINGS

There is no State emergency response plan for the Delta.
Consider restating the problem like this: "The State has failed to meet its obligation to develop an emergency response plan for the Delta." There is a response plan, in the sense that there are prescribed procedures involving OES, the State Flood Board, DWR, etc. These plans are basically prescribed by

procedures involved when the governor declares a state of emergency. But the State has failed to develop an updated, legislatively mandated emergency response plan specific to the Delta.

Emergency preparedness is the first line of flood defense and local agencies are the primary responsible agents.
Emergency preparedness is a partnership with State government; it is not the sole responsibility of cities, counties, or reclamation districts. The State is responsible for coordinating and, as appropriate, directing and even funding the activities.

Recent floods stimulate emergency response planning, but the porcess [sic] is far too slow.
Suggest combining this problem with the first one, about the State response plan.

Subsided islands are at the highest risk of flooding and are likely to subscumb [sic] to flood[ing] over the coming decades.
- Could cover this topic in a well-illustrated introduction to the chapter (suggestions above).
- If nonetheless retained: How many islands? How likely? During an earthquake? What about a big river flood, as in January 2006? Though the deeply subsided islands are subject to levee failure, so are all other Delta islands, deeply subsided or not, and the hazard varies from place to place.
- Perhaps more to the point, for matters of policy, is the question of priorities for levee maintenance, improvement, realignment, and removal or abandonment. What finding, for instance, would guide policy on post-flooding decisions about which islands to restore and which to leave flooded? Such questions are raised by the next big heading ("...promoting strategic levee investments") but are not yet addressed beneath it except in the selective example of setback levees.

The Delta is flood prone.
Suggested rewrite: "The Legislature has designated the Delta as flood prone." The paragraph might also recap why the Delta is prone to flooding – by means of levee failure.

Delta levees are also threatened by earthquakes.
- The writers could explain this threat more clearly and evaluate it more critically. How uncertain are the underlying assessments of earthquake probabilities, ground motions, and levee responses?
- Here or in the chapter's introduction, or in both places, the writers could put earthquakes in the context of other causes of Delta levee failure. This effort could include an assessment of the conclusion, on page 2 of the 2009 DRMS Phase 1 Executive Summary, that earthquakes are the leading threat to Delta levees.
- The earthquake sources that threaten, or may threaten, Delta levees go beyond those summarized in the summed average probability for Bay Area faults, which might therefore be played down. The summed average, as estimated in the Working Group on California Earthquake Probabilities (WGCEP) reports cited below, is dominated by the San Andreas and Hayward faults and excludes faults beneath and beside the Delta.
- What could be provided in place of a WGCEP average includes: a map showing all the faults that contribute to the Delta hazard, including faults that underlie or adjoin the Delta; a tabular or graphical summary of what's known and what's unknown about Holocene displacement on these faults; and another figure or table that spells out each fault's estimated contribution, at various probabilities, to Delta seismic hazards.

Levees do not eliminate risk—levees reduce risk.
What about levees that stimulate urban development behind them?

Levee safety status quo is unacceptable.
This glib statement could be fleshed out, and it could be supported by being placed in the context of risk and illustrated with examples from the Delta.

Setback levees provide multiple benefits.
This finding could be presented as part of a way of addressing problems.

Findings on reducing risks to Delta infrastructure

- Suggest citing the Delta Risk Management Strategy (DRMS) not just here but in sections above. Risk reduction was precisely the goal of the DRMS study.
- The water supply infrastructure, as it relates to conveyance, could be called out into a separate section. It is buried late in this section, yet it is the most important economic feature of the Delta.
- The first two findings on infrastructure could be combined into one. Most of the others could be sorted by roads, railroads, and utilities (water, gas, electricity), with discussion of the unique threats to each.
- The last finding singles out climate change as a threat to important infrastructure without putting it in the context of other levee stressors that could be reviewed in the chapter introduction.

REFERENCES FROM THE DELTA RISK MANAGEMENT STRATEGY (DRMS) STUDY

URS Corporation/Jack R. Benjamin & Associates, Inc., 2007, Topical area: seismology. Technical memorandum, [final version], Delta Risk Management Strategy (DRMS) Phase 1, prepared for California Department of Water Resources, 32 pp., 6 tables, 115 figures, appendix, http://www.water.ca.gov/floodmgmt/dsmo/sab/drmsp/docs/Seismology_TM.pdf

This report assesses hazards from more potential sources of earthquakes than do the California earthquake probability reports cited below. The additional earthquake sources are mainly beneath or beside the Delta. They contribute to the estimated hazards as sources of earthquakes that, although infrequent or doubtful, would be close enough to the levees to cause strong shaking. The earthquake potential of these sources is less understood than that of the main active faults in the San Francisco Bay area. In some cases the key evidence cited is proprietary data – a limitation worth acknowledging in the Delta Plan itself and spelling out in the "fact sheet" about the Plan's findings concerning the Delta's earthquake hazards.

URS Corporation/Jack R. Benjamin & Associates, Inc., 2008, Seismic risk analysis, *in* Risk analysis report [final version], Delta Risk Management Strategy (DRMS) phase 1, prepared for California Department of Water Resources, U.S. Army Corps of Engineers, and California Department of Fish and Game, http://www.water.ca.gov/floodmgmt/dsmo/sab/drmsp/docs/Risk_Report_Section_6_Final.pdf

Includes engineering analyses of levee stability, in addition to much of the material in the 2007 report. Appendix B contains critical comments of an earlier version of the report. How well does the final version address the reviews' main concerns?

California Department of Water Resources, 2009, Executive summary, Delta Risk Management Strategy phase 1, 24 p., http://www.water.ca.gov/floodmgmt/dsmo/sab/drmsp/docs/drms_execsum_ph1_final_low.pdf

This report, on its second page, says that earthquakes surpass all other hazards to Delta levees. What is the basis for this ranking?

REFERENCES ON CALIFORNIA EARTHQUAKE PROBABILITIES

2007 Working Group on California Earthquake Probabilities, 2008, The uniform California earthquake rupture forecast, version 2 (UCERF 2): U.S. Geological Survey Open-File Report 2007-1437 and California Geological Survey Special Report 203, http://pubs.usgs.gov/of/2007/1091/.

The estimates in this 2008 report, which appeared after most of the DRMS effort, supersede those from 2003, below. Does the existing Delta Plan draft cite the obsolete 2003 numbers?

Working Group on California Earthquake Probabilities, 2003, Earthquake probabilities in the San Francisco Bay region: 2002–2031. U.S. Geological Survey Open-File Report 2003-214, pubs.usgs.gov/of/2003/of03-214/.

TWO RECENT REFERENCES ON 21ST-CENTURY SEA-LEVEL RISE

Rignot, E., Velicogna, I., van den Broeke, M.R., Monaghan, A., and Lenaerts, J., 2011, Acceleration of the contribution of the Greenland and Antarctic ice sheets to sea level rise: Geophysical Research Letters, v. 38, no. 5, L05503, doi: 10.1029/2011GL046583

The writers estimate that ice-sheet melting alone will raise sea level a half meter by the year 2100.

Willis, J.K., Chambers, D.P., Kuo, C.-Y., Shum, C.K., 2010, Global sea level rise – Recent progress and challenges for the decade to come. Oceanography, v. 23, no. 4, p. 26-35, http://www.tos.org/oceanography/articles/23-4_willis.pdf.

The projections in this article range from 0.5 m to 1.5 m (Figure 2, page 30).

Chapter 9 – Protect and Enhance the Unique Cultural, Recreational, Natural Resources, and Agricultural Values of the California Delta as an Evolving Place

General comments:

1. Many findings are presented; almost none are problem statements. Many are simply statements of fact, others are statements of policy goals, yet others are political declarations.
2. Aside from passing mention of the natural resources on p. 1, there are few findings that specifically address natural resources. Surely these are an important part of the Delta, part of its heritage and its unique appeal. Hopefully, subsequent Draft Plans will address this need more specifically.

3. The bases of most of the findings in this Chapter are simply statements given in agency reports, commission findings, legislative declarations, or executive orders. If the findings are to have real credibility as being science-based, the basis must be in data. The existing basis may provide policy support for the findings, which is important. But to be science-based the Delta Plan must be more solid than a consolidation and confirmation of previous reports. This needs to be remedied in future drafts.

From the Basis of Findings document
p. 9-3: This finding essentially repeats that given on p. 9-1.

p. 9-5: This finding draws attention to the need and the opportunity to adjust the management of agricultural lands in the Delta to enhance wildlife habitat. For example, tuning the timing of harvests or seasonal flooding of agricultural fields to coincide with the periods of peak use by migratory waterfowl, cranes, or shorebirds may improve habitat with minimal costs. The joint Nature Conservancy-California Audubon-PRBO Conservation Science Migratory Bird Partnership in the Central Valley is developing guidance for practices that could be applied in the Delta.

p. 9-11: At some point, it will be important to couple the projections of population and urbanization growth with those of climate change and its potential impacts on water supplies and agricultural production. Attempting to develop a comprehensive Delta Plan by considering any one of these without the others may lead to incomplete or incorrect recommendations.

p. 9-15: This finding is so vague as to be useless.

p. 9-21 through 9-25: Unless more specifics are developed, these three findings could easily be combined; they are essentially duplicate statements of the same thing. But surely data are available!

p. 9-27: This finding overlaps the previous ones, but with an emphasis on the habitat and recreational values associated with natural resources. The finding should be more sharply focused on these specific values if it is to lead, eventually, to management or policy recommendations.

p. 9-31: Again, we can document the agricultural production on Delta farmland and compare it with other parts of the State. Use numbers.

p. 9-33: This finding largely repeats that given on p. 7. It would be good to sharpen the focus and reduce the redundancy among findings.

p. 9-37: This finding overlaps and contains much the same language as the finding on p. 7 of Chapter 8. The differences in emphasis are important, but this overlap also illustrates the need to cross-link findings among chapters with different foci. Similar findings that appear in different chapters and context gain greater importance, which should be highlighted. In other words, future drafts should aim to achieve greater coordination and cross-referencing among chapters.

p. 9-39: With the exception of specifics about population growth, this is the same finding as that given on p. 7.

p. 9-41: This finding relates back to the previous findings on land-use planning and simply restates previous findings. Such redundancy detracts from the impact of the findings as a whole.

p. 9-45: See comments on p. 9-5.

p. 9-47: This finding contains a real sense of urgency that is missing from many of the findings. Consequently, it deserves to be highlighted in some way. The reality that the Delta ecosystem and all that it supports is on the cusp of multiple tipping points, any one of which could lead to dramatic and disastrous environmental, economic, and social consequences must be emphasized up front in the Plan. If the Plan comes across as just another report and plan by just one more state entity, it will be unlikely to have the impact that is needed. Somehow, people must be made to realize that this is *the* Plan, and that a failure to act on its findings and recommendations may condemn the Delta to follow a new, uncertain, and probably undesirable trajectory.

Summary: This chapter is highly redundant yet not solid at all, redundant flab all through.